Electromagnetic Phenomena with Potential

Introduction

Nikola Tesla, the Serbian born American inventor, had invented or worked on most of the electric appliances and devices we use today or had his touch on it. In 1946, after his death in 1943, it was ruled that he invented wireless radio transmission ahead of Hertz and Marconi even though he favored another form of transmission that was in his words neither conductive nor radiative. He even envisioned in US US patents number 723188 and 725605 a form of frequency division multiplexing to increase the rate of data communications as was invented in 1992 and 1995 by Fattouche and Zaghloul (US5,282,222 and RE37,802) that laid the foundation for today's high speed communications.

In 1985, Zaghloul, K. Volk and Buckmaster proved that electromagnetic waves with the electric and magnetic fields parallel to each other are proper solutions of Maxwell's equations. The simplist of these waves are circularly polarized monochromatic standing waves. Zaghloul and Buckmaster, later gave interesting applications for these exceptional fields. In 1990, Zaghloul and Barajas solved the force-free magnetic fields equation in spherical coordinates. Force-free magnetic fields were proposed by Nobel prize winner Chandrasekhar as the configuration that prevents stars made of positive nuclei from imploding. Chandrasekhar's solutions were attempted for nuclear fusion spherical tokamak reactors. However, the solutions were in error. The solutions of Zaghloul and Barajas are now incorporated in the fusion reactor work.

The above illustrates that there is a lot of fundamental work in electromagnetism.

We continued with our interest in fundamental work on electromagnetics. We see that there are a few areas of research that need further analysis. We do not intend this list to be comprehensive. It only shows the areas that we felt are of interest.

Weather Manipulation

The ionosphere is positively charged and that this causes its electric potential to be higher than that of V. The average distance from 280,000 the earth by km. This leads to 100 the ground to the ionosphere is 2.8 = 100,000 / 280,000 an average electric field of to 100 V/m. it is known that there is an electric field of V/m under fair wizard conditions. The literature 300 generally attributes this electric field to the potential difference between the ionosphere and the ground. Obviously, there should be another mechanism .generating this electric field

The electric discharge during lightning excites the atmosphere in the frequency spectrum from zero to 100 kilohertz. These excitations bounce between the ground and ionosphere. Most of

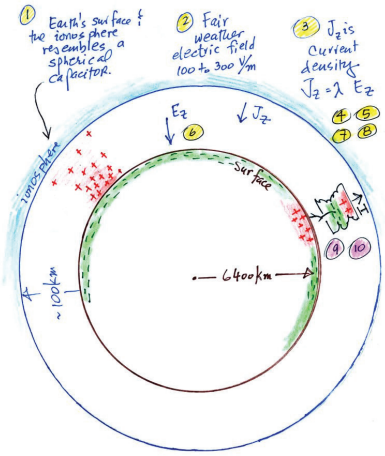

Figure 1 A schematic of the earth's atmosphere illustrating the different potentials, fields and currents present. Courtesy Univ of Arizona ATMO 589.

these excitations fade away with time. Certain excitations whose wavelengths matches the circumference of the earth (or an integral division thereof) or are solutions to the spherical Legendre polynomials resonate and remain in the atmosphere. These are known as the Schumann resonances. The fundamental wave has a frequency of 7.6 Hz. This wave has a wavelength equal to the circumference of the earth. The earth and the ionosphere form a spherical capacitor.

There are many experimentations and some actual products on the market that claim to generate different weather conditions. This is through the production of ions. Most systems on the market generate 0.5M ions per cm^3. Magnetic Technologies of Dubai developed a system that can produce up to 20M ions per cm^3. Needless to say, experimenting with such systems needs to be gradual. However, some systems are already in use in the Middle East.

There is speculation that the US has developed a system (HAARP) capable of generating sever weather conditions that may be responsible for some of the Tsunami catastrophes.

Electricity Distribution and Harnessing from the Atmosphere

As stated above, there are resonances in the atmosphere. The energy in these resonances is large. The source of this resonance is lightning. If we assume that lightning is the source of the 100 to 300 V/m electric field during fair weather, we find that the current coming down from the ionosphere to the ground is 2000 A.

Nikola Tesla head experimented with harnessing energy from the atmosphere in stated in one of his patterns that he received more energy than he transmitted. Note that the power flowing during fair weather is the product of the potential times the current (280kV x 2kA) is 560MW. An average lightning bolt has about 1 billion joules of energy. There are 8 lightning bolts on the average every second. This means that the energy in these bolts is about 8GJ every second or 8GW; about 15 times the amount flowing down to the ground. This is probably due to that most of these lightning bolts balance each other; meaning, some lightning bolts bring down positive charges and others bring down negative charges with a difference in favour of the positive charges. We speculate that this balance will always be maintained if we were to use the 560MW. This means that we can, theoretically, use the entire energy of the lightning.

The biggest difficulty in dealing with this energy is how to build a receiver for the signals. Typically an efficient antenna should be about one quarter of the wavelength of the signal. If the wavelength is of the order of the circumference of the earth, it is not practical to build such an antenna. Some work has been done to operate devices close to their cut-off whereby the electric length is appreciably different than the actual length. Jones Corum, in US Patent 4.622,558, Toroidal Antennas, November 8, 1986, showed that a reduction by a factor of 10 is possible. Also, Corum targeted using a frequency of 100MHz which corresponds to a wavelength of 3m. Franz Pertl, Robert Craven and James Smith, in US Patent 6300920B1, Electromagnetic Antennas, October 9, 2001, described a multitude of antennas without giving actual dimensions for those antennas.

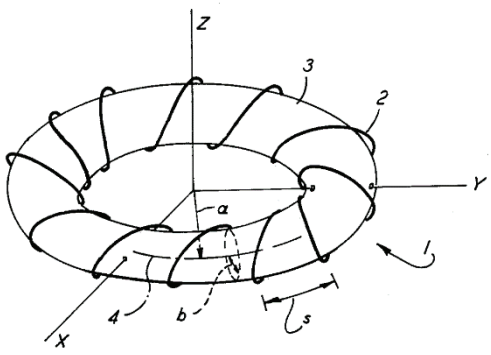

Figure 2 Example of a toroidal antenna (Fig 2 of US 4,622,558 patent)

The Earth as a Conductor

In US patent No. 787,412, Art of Transmitting Electrical Energy Through the Natural Medium by Nikola Tesla, Apr 18, 1905, Tesla talks about conducting a signal through the entire earth.

He observed that by studying the electric disturbances in the earth due to lightening, that some points show no response when they should. He analyzed and found that this is cyclic and has a period of 25 to 70 km. He claims to have observed that these disturbances reach the furthest points of the globe. In patents, 645,576 and 649,621 he described a potential generator that can transmit signals through the earth. In patents, Nos. 685,953 and 685,955 he described potential receivers. He claims to have shown results surpassing those of a lightening discharge.

He postulated three conditions for it to work:

First: The earth's diameter passing through the pole should be an odd multiple of the quarter wave length- that is, of the ratio between the velocity of light- four times the frequency of the currents.

Second: It is necessary to employ oscillations in which the rate of radiation of energy into space in the form of Hertzian or (Transverse) electromagnetic waves is very small. To give an idea, I would say that the frequency should be smaller than twenty thousand per second, though shorter waves might be practicable. The lowest frequency would appear to be six per second, in which case there will be but one node, at or near the ground-mate. And paradoxical as it may seem, the effect will increase with the distance and will be greatest in a region diametrically opposite the transmitter. With oscillations still slower the earth, strictly speaking, will not resonate, but simply act as a capacitor; and the variation of potential will be more or less uniform over its entire surface.

Third: The most essential requirement is, however, that irrespective of frequency the wave or wave-train should continue for a certain interval of time, which I have estimated to be not less than one-twelfth or probably 0.08484 of a second and which is taken in passing to and returning from the region diametrically opposite the pole over the earth's surface with a mean velocity of about four hundred and seventy-one thousand two hundred and forty kilometers per second.

Wireless Chargers

In US Patent No. 7,741,734B2 Wireless Non-Radiative Energy Transfer, 2010 – Originally filed 2005, they classify the field as oscillatory resonant electromagnetic mode. They define long distances to be distances that are much greater than the device's dimensions. They suggest that the energy transfer is through coupling of the resonant field evanescent tails of the two resonators. They call it non-radiative because the distance between the two resonators is smaller than the two wavelengths. They suggest that the quality factor of the resonators must be greater than 100 to achieve wireless power transmission.

Another language for the evanescence tail is coupling mode theory which was used extensively to study resonance between waveguides since the 1950s.

We can think of the process of wireless charging as energy tunnelling. The energy disappears from one coil and appears at the other.

US Patent No. 8,772,972B2, MIT 2014. Originally filed 2006 is an extension of the 7,741,734B2 patent above to cover the case of a mobile receiver while limiting the distance to less than the wavelength of the signal transmitted.

The Qi wireless charger uses the concepts in these patents and a frequency of 100kHz. Its average power transfer is below 5W. ChargeEdge of Silicion Valley has managed to transfer 80W with smaller coils. ChargeEdge says that by not having the two coils at exactly the same frequency improved the performance.

Wireless Electricity via Surface Waves

According to The Net Advance of Physics: SPECIAL REPORTS, No. 1, ELECTROMAGNETIC SURFACE WAVES, by David Reiss, "This so-called Zenneck wave is simply a vertically polarized plane wave solution to Maxwell's equations in the presence of a planar boundary that separates free space from a half space with a finite conductivity. For large conductivity -- this depends on the frequency and dielectric constant, too -- such a wave has a Poynting vector that is approximately parallel to the planar boundary. The amplitude of this wave decays exponentially in the directions both parallel and perpendicular to the boundary (with differing decay constants)."

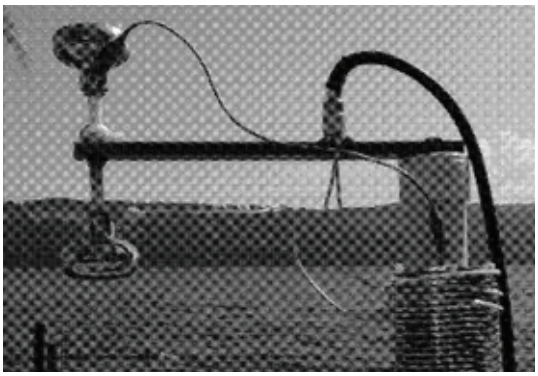

Figure 3 An image of the surface wave probe described by Corum and Corum in US Patent 10224589 (Fig 14A of the patent)

According to Corum and Corum in US Patents 10224589, 9887558, and 9910144, "A guided electromagnetic field is a propagating electromagnetic wave whose energy is concentrated within or near boundaries between media having different electromagnetic properties. In this sense, a guided electromagnetic field is one that is bound to a waveguide and may be characterized as being conveyed by the current flowing in the waveguide. If there is no load to receive and/or dissipate the energy conveyed in a guided electromagnetic wave, then no energy is lost except for that dissipated in the conductivity of the guiding medium. Stated another way, if there is no load for a guided electromagnetic wave, then no energy is consumed. Thus, a generator or other source generating a guided electromagnetic field does not deliver real power unless a resistive load is present. To this end, such a generator or other source essentially runs idle until a load is presented. This is akin to running a generator to generate a 60 Hertz electromagnetic wave that is transmitted over power lines where there is no electrical load. It should be noted that a guided electromagnetic field or wave is the equivalent to what is termed a "transmission line mode." This contrasts with radiated electromagnetic waves in which real power is supplied at all times in order to generate radiated waves. Unlike radiated electromagnetic waves, guided electromagnetic energy does not continue to propagate along a finite length waveguide after the energy source is turned off. Accordingly, the term "guide" in all its forms as used herein refers to this transmission mode of electromagnetic propagation."The subject of surface waves suffered a major blow in the 20th century since there was a speculation that there was a sign error in one of Somerfeld's equations. The error was declared a hoax in 2004. Recent work by Corum and Corum suggest that these waves provide a lot of potential for wireless electricity.

Quaternion Maxwell Equations

Quaternions are mathematical quantities that were introduced in the 18th century. Dr. Arbab Arbab of Alqassim University, Saudi Arabia, applied them to electromagnetics. A quaternion **A**

$$\hat{A} = A_0 + A_1 i + A2\, j + A_3 k$$

Where

$$i^2 = j^2 = k^2 = -1, \text{ and } ij = k, jk = I, \text{ and } ki = j.$$

$$\hat{A}\hat{B} = (A_0 B_0 - A \cdot B) + (A_0 B + A B_0 + A \times B)$$

Introducing the quaternion Laplacian

$$\hat{\Box}^2 = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \nabla \cdot \nabla$$

The electromagnetic vector potential quaternion

$$\widehat{\boldsymbol{A}} = (\frac{i\phi}{c}, A)$$

If we assume that the wave equation for this vector potential is

$$\widehat{\square}^2 \widehat{\boldsymbol{A}} = \mu_0 \hat{\boldsymbol{J}}$$

Where $\hat{J} = (ic\rho, J)$ is the quaternion source (charge density and current density). It is natural to assume this form of quaternionic wave equation for mathematical symmetry but we note that it is different than the wave equations obtained from the normal Maxwell equations.

Solving these equations leads to modified Maxwell equations

$$\nabla \times E = -\frac{\partial B}{\partial t}$$

$$\nabla \times B = \mu_0 J + \frac{\partial E}{\partial t} + \nabla \Lambda$$

$$\nabla \cdot E = \frac{\rho}{\epsilon_0} + \frac{\partial \Lambda}{\partial t}$$

$$\nabla \cdot B = 0$$

Where $\Lambda = -\left(\frac{1}{c^2}\frac{\partial \phi}{\partial t} + \nabla \cdot A\right)$ can be termed the gauge factor. In the case of the Lorentz gauge, Λ is null and we get the ordinary Maxwell equations. Of course, this gauge factor is not present if we start from Maxwell's equations like in standard electromagnetics.

The effect of Λ could result from the non-uniformity of the medium (background) in which the electromagnetic field exists. The non-uniformity in pressure leads to piezoelectricity, in temperature leads to thermoelectricity, and in phase leads to Josephson junction (considered to be a quantum effect).

He extended the biquaternionic Dirac's equation to include interactions with a background bosonic field. The biquaternionic Dirac equation yields Maxwell-like equations valid for matter field as well as electromagnetic field. The electric field is found to be perpendicular to the matter magnetic field, and the magnetic field is perpendicular to the matter inertial field. Inertial and magnetic masses are found to be conserved separately. Arbab's analysis led to [vii]

$$\nabla \times E_D = -\frac{\partial B_D}{\partial t} - \frac{q}{\hbar c}\varphi_g E_D - \frac{qc}{\hbar} A_g \times B_D$$

$$\nabla \times B_D = \mu_0 J_D + \frac{1}{c^2}\frac{\partial E}{\partial t} + \frac{qc}{\hbar} A_g \times E_D - \frac{q}{\hbar c}\varphi_g B_D + \frac{qc}{\hbar} A_g \times E_D$$

$$\nabla \cdot B_D = \rho_{mD}$$

Where the subscript D denotes inertial matter quantities which Arbab related to the state function of the matter. Interestingly the axion electrodynamics of Nobel Prize winners Frank Wilczek and Chert-Simon emerges as a special case of these equations. This work had led to the discovery of topological insulators. The generalized equations of Arbab should lead to the discovery of more interesting phenomena.
One such phenomenon is the mass of the photon: while the photon was deemed to be massless, a possibility of massive photons can be entertained in this framework. When the electron interacts with the electromagnetic field, the particle behaviour of light can be calculated, and its implications can be studied.

Totally Secure Communications

US Patent No. 5,845,220 Communication Method and Apparatus with Signals Comprising Scalar and Vector Potentials Without Electromagnetic Fields, Haold E. Puthoff, Dec. 1, 1998. Continuation of application filed in 1991.

The receiver invented in this patent is a Josephson junction (two semiconductors connected by a thin wire). Gelinas had earlier proposed the same. The difference between the two is that Puthoff proposed that the electric and magnetic fields be suppressed. So, the communications is done by a curl free vector potential (**B** = 0) and a grad of the scalar potential cancels out with the negative of the time derivative of the vector potential (**E** = 0).

He claimed the general communication system where the vector and scalar potentials are used in the absence of electric and magnetic fields.

The main advantage of his invention is that vector and scalar potentials penetrate electric shields such as Faraday cages. He suggests that his communications scheme can be used side by side with existing communications systems since he does not use the electric and magnetic fields.

A key advantage of his invention is that it is secure in the sense that traditional receivers cannot receive it.

Magnetic Devices

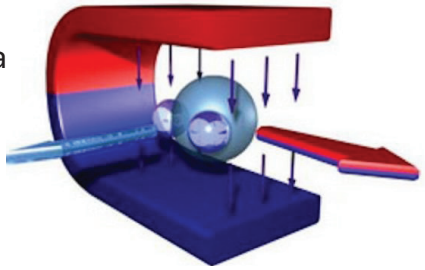

Figure 4 Figure showing the force on a moving charge in a magnetic field.

It is known that applying a magnetic field on a moving charge introduces a force on the charge proportional to the charge, its velocity, and the .4 strength of the magnetic field. A schematic of this force is shown in Fig A molecule made up of a number of atoms will have its electrons and nuclei subjected to different forces when placed in a magnetic field as Note that in a molecule of water, the Oxygen ion is .5 shown in Fig negatively charged and the two Hydrogen ions are negatively charged. This means that the Hydrogen ions will be subjected to a force in the opposite direction of the force on the Oxygen ion. This would cause the molecule to be polarized and elongated. This effect would normally vanish as soon as the field is removed. However, if the field is strong enough to cause the ions to sit in a new configuration that is stable, the material, water in the example, will be in a different phase than before the field is applied. We know of the first order phase transitions where a material changes from solid to liquid then to gas. Each of these are a different states (phases) of the same material. There are phase transitions that are not associated with a change of state; these are called second order phase transitions. An example of a second order phase transition is 4DEGC where it starts to expand the change that happens in water at rather than shrink the temperature decreases. A number of products appeared in the market utilizing this concept. Magnetic Technologies of Dubai has over 70 such products.

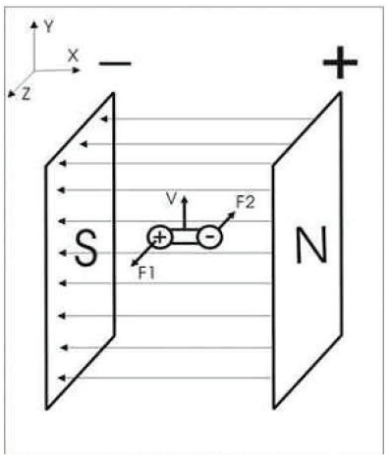

Figure 5 Figure showing the polatization of an atom in a magnetic field

Magnetic Fuel Modifier

A simple device that can be inserted in the fuel line of benzine and diesel engines. Magnetic Fuel Modifier changes the physical structure of the fuel by breaking the long molecular bonds of hydrocarbons, resulting in the intensification of the burning process. This modification of fuel reduces fuel consumption and emission of toxic gases. It is noteworthy that the fuel oil treated by a magnetic fuel modifier will produce significant economic factors that get better with the aging of the motor. These include more efficient fuel burning (more miles per gallon) and less emissions.

Figure 6 Figure showing the magnetic fuel modifier from Magnetic Technologies and its part number

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Inovatian

inovatian is an Egyptian private company. It was incorporated in 2016 and has been mainly funded by its founder **Dr. Hatim Zaghloul,** who, along with Dr. Michel Fattouche invented the wireless communication protocols that changed the world over the past 25 years; they invented the WOFDM and MCDSSS which are the basis for the high speed wireless communications we are currently experiencing in WiFi, WiMAX, 3G, 4G/LTE and 5G standards. Inovatian currently operates out of 4 countries: Inovtian Inc. in Egypt, Inovatian Limited in the US, Inovatian Europe ab in Sweden and Inovatian Telecommunications Sarl in Chad.

Inovatian is leading the charge towards a 6G standard for mobile telephony based on the vision of decentralizing the network through blockchain and mesh; reducing the cost of smart devices through the introduction of virtual mobile terminals and having it native to the standard.

Our first product into this field, the InoMesh, is a state-of-the-art mesh WiFi product that keeps the data rate high even after many hops. Our second product is a blockchain and an associated digital currency that will help decentralize the network. Our third product will be a competitively priced high-performance smart device that acts like a virtual terminal. Our fourth product will be an artificial intelligence system that is distributed over the computers and processors forming the blockchain to help profile the users and provide them with better service. The last product is a media delivery system based on the profiling. This could lead to the integration of the broadcasting and the telecommunications industries

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